Conservative and Nonconservative forces

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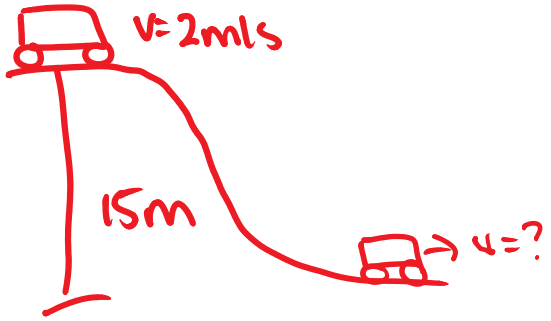
A rollercoaster has a mass of 500 kg and is at the top of a 15 m tall hill. If it has a velocity of 2 m/s at the top of the hill, what is its velocity at the bottom of the hill? (Assume no friction)



$ME_i = ME_f$

$PE_{gi} + PE_{ei} + KE_i = PE_{gf} + PE_{ef} + KE_f$

$PE_{gi} + KE_i = KE_f$

$mgh_i + \frac{1}{2}mv_i^2 = \frac{1}{2}mv_f^2$

$500 \cdot 9.8 \cdot 15 + \frac{1}{2} \cdot 500 \cdot 2^2 = \frac{1}{2} \cdot 500 \cdot v_f^2$

$73{,}500 + 1000 = 250\, v_f^2$

$74{,}500 = 250\, v_f^2$

$298 = v_f^2$

$17.3 \text{ m/s} = v_f$

Now suppose we have a force of friction of 45 N per m. The rollercoaster travels a total distance of 50 m as it goes down the hill. Find the velocity as it travels down the hill

$F_f = 45 \text{ N}$

$x = 50 \text{m}$

$W_f = F_f \cdot x = 45 \cdot 50 = 2250 \text{J}$

$W_{nc} = ME_f - ME_i$

$E_{bif} = E_{after}$

$PE_{gi} + KE_i = KE_f + W_f$

$mgh_i + \frac{1}{2}mv_i^2 = \frac{1}{2}mv_f^2 + F_f \cdot x$

$73{,}500 + 1000 = 250 v_f^2 + 2250$

$74{,}500 = 250 v_f^2 + 2250$

$72250 = 250 v_f^2$

$289 = v_f^2$

$v_f = 17 \text{ m/s}$

A 5 kg brick slides down a 3 m long ramp that is titled to a 40 degree angle above the horizontal. The coefficient of friction is .2. What is the brick's velocity at the bottom of the ramp?

At start

$PE_{gi} = mgh_i$

$= 5 \cdot 9.8 \cdot 1.93$

$= 94.5\ J$

$h_i = 3 \cdot \sin 40 = 1.93\ m$

$W_{friction}$

$F_N = F_\perp = F_g \cos\theta = mg\cos\theta = 5 \cdot 9.8 \cdot \cos 40 = 37.5\ N$

$F_f = \mu F_N = 0.2 \cdot 37.5 = 7.5\ N$

$W_{fric} = F_f \cdot x = 7.5 \cdot 3 = 22.5\ J$

$E_{bif} = E_{after}$

$PE_{gi} = KE + W_f$

$94.5 = KE + 22.5$

$72 = KE$

$72 = \frac{1}{2}mv^2$

$72 = \frac{1}{2} \cdot 5 v^2 = 2.5 v^2$

$28.8 = v^2$

$v = 5.37\ m/s$

$W_{nc} = ME_f - ME_i$

$W_{nc} = KE_f - PE_{gi}$

$-22.5 = KE - 94.5$

$72 = KE$

W_{nc} will be negative because resists motion slows things down